***Campino A.C.C.*[1], *Machado F.M.S.*[2] Human capital and regional economic growth in Brazil**. .

ABSTRACT

This research incorporates recent advances in the economic growth theory that relates health, human capital, and long-term economic growth. The evidence is obtained from the analysis of an important database, Pesquisa de Padrão de Vida, a household survey conducted in Brazil, between 1996 and 1997, for the Northeast and Southeast regions.

The impact on the economic and social performance is evaluated by comparing the results obtained for the richest metropolitan region of the country, São Paulo, located in the Southeast – that has an economic and social profile similar of the ones of developed countries - with the results obtained for the poorest metropolitan region of the country, Fortaleza, located in the Northeast - that has an economic and social profile similar of the ones of underdeveloped countries. Results lead to the conclusion that relevant investments in human capital formation, as education, create better opportunities to the individual in terms of employment and income. However, beyond these primary effects, there are secondary effects, mainly based on the transmission of human capital formation through generations, which result in population lifestyle changes, economic growth and development.

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1 - INTRODUCTION

There are databases in Brazil that allow for intertemporal comparisons on the evolution of the population's nutritional status permitting the analysis of correspondence between this evolution and changes in socioeconomic characteristics of the population, as well as associating anthropometric differences (height and weight) to distinct levels of income.

The main objective of this research is to assess the impact of nutrition and health status of the population on the human capital formation and long-term economic growth and social development in Brazil through a cross-section analysis.

Height of the individual will be used as a proxy for human capital investment made on this individual by his family and by the government, as expressed by Fogel (2001). Population data regarding adults in the range of 19 to 59 years old will be used, because this is an age group on the prime of its economic activity. People older than 60 years will not be included, since the precise assessment of height in this age group is more difficult.

The source of the data analyzed in order to reach the proposed goal is the Living Standards Measurement Survey, or Pesquisa de Padrão de Vida (PPV), a household survey conducted between 1996 and 1997 in both the Southeast and Northeast Regions of Brazil.

The PPV program was carried out by the Brazilian Institute of Geography and Statistics (IBGE) in association with the World Bank, in order to enhance the socioeconomic statistics system. It is the Brazilian version of the LSMS and consists of a pilot project of multitheme research to fulfill information needs which: (a) qualify and indicate the determinants of social welfare of different social groups, and (b) allow for the identification of the effects of government policy on household living standards. The main objective of PPV being that of providing adequate information for the planning, following up, and analysis of economic policies and social programs vis-à-vis their impacts on household living standards, especially among low-income populations. Due to its broad thematic approach, PPV generates optimum multidimensional summary of welfare factors and permits the study of the interaction of several variables associated to welfare (IBGE, 1998).

PPV includes data on age, height, weight, self-reported health status, education, and income of the population. The PPV achievements are very important, moreover since this has been the first socioeconomic and demographic survey carried

out in Brazil following the implementation on July 1994 of the stabilization plan known as the ”Real Plan”.

The PPV sample design was discussed with World Bank officials while sample size has been determined by the available budget. In accordance to its pilot-research configuration, it was decided that it would only cover the Southeast and Northeastern Regions of Brazil, taking into consideration 10 geographic strata, namely: Fortaleza, Recife, and Salvador Metropolitan areas; the remaining urban areas of the Northeast; the remaining rural areas of the Northeast; Belo Horizonte, Rio de Janeiro, and Sao Paulo Metropolitan areas; the remaining urban areas of the Southeast; and the remaining rural areas of the Southeast (IBGE, 1998).

2. THEORETICAL BACKGROUND

Economic development textbooks define economic growth as growth in income *per capita* and economic development as a process that implies transformations in social structure, such as education, health, nutrition, access to housing and sanitation that, on their turn, imply growth in per capita income.

Human capital “is the most fundamental source of economic growth. It is a source of both increased productivity and technological advance”.[3] Investment in human capital, as defined by the founding father of the human capital theory, Gary Becker, is the imbedding of resources in people that influence future real income.[4]

Therefore, the investment in human capital has an important impact on the economic development of a country. One of the forms of investment in human capital is the expenditure in education. It has been proved that expenditures in education are important in explaining the rate of growth experienced by a country. One of the earliest studies in this area, conducted by Edward F. Dennison, has shown that 40% of the rate of growth of the United States in the period 1929-1957 could be attributed to expenditures in education.[5]

A number of studies in developing countries have shown that there is an important relationship between education and health of the next generation, measured in

[3] Parkin, Michael Macroeconomics 5th ed. 2000 Addison-Wesley Publishing Co.Inc. p.230.

[4] Becker, Gary S. “Investment in Human Capital: A Theoretical Analysis” chapter 3 in Febrero, Ramon and Schwartz, Pedro S. The Essence of Becker Hoover Institution Press Stanford University Stanford California 1995 p.36.

[5] See Dennison, E.F. Why growth rates differ; postwar experience in nine western countries Edward F. Denison, assisted by Jean-Pierre Poullier. Washington, Brookings Institution [1967], 494 and also

terms of life expectancy; the mechanism by which this relationship is revealed resides in improvements in infant and child survival rates (Caldwell, 1986; Cochrane, Leslie and O'Hara, 1982; D´Souza and Bhuiya, 1982; Le Vine, 1987 quoted by McMahon, 1999:82). The hypothesis is that the knowledge and increased earnings potential gained through education enable parents to provide a healthier environment for their families, although the mechanisms through which this occurs are still unclear (Le Vine, 1987; Eisemon, 1988, referred by McMahon, p. 83). The regressions run by McMahon show that infant mortality rates are dependent on female gross enrollment rates, lagged 20 years (McMahon, p. 84).

Becker and Tomes assumed a different position, on the paper "Human Capital and the Rise and Fall of Families" (Becker and Tomes, 1986), developing a theoretical model of the transmission of earnings, assets and consumption from parents to descendants. Becker and Tomes depart from a simple model of the relation between the parents' and children's incomes.

$$I_{t+1} = \alpha + b\, I_t + \varepsilon_{t+1}$$

Where It is the income of the parents, I_{t+1} is the income of children, α and b are constants and the stochastic forces affecting the income of the children ε_{t+1} are assumed to be independent of the income of parents[6].

The second hypothesis is that the endowments of a family are inherited from their parents, but only partially so. This relation is expressed as

$$E_{i\,t} = \alpha_t + h\, E_{i\,t-1} + \upsilon_{I\,t}$$

Where $E_{i\,t}$ is the endowment of the ith family in the tth generation, h is the degree of inheritability of these endowments, and $\upsilon_{I\,t}$ measures unsystematic components of luck in the transmission process[7].

Having specified relationships for the transmission of income and of endowments from one generation to the other, the authors elaborate on the relation

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Dennison, E.F. Accounting for United States economic growth, 1929-1969` Washington, Brookings Institution [1974], 355p.

[6] Acc.Becker and Tomes, p.344.

[7] Becker and Tomes, p.347.

between earnings and human capital. They assume that adult earnings depend on human capital formed in childhood and market luck (L):

$$Y_t = \gamma (T_t, f_t) H + L$$

Where Y_t stands for earnings, and the earnings of one unit of human capital γ is determined by equilibrium in factor markets, technological knowledge (T_t) and the ratio of the amount of human capital to nonhuman capital f_t.

This equation allows for the transformation of investments in human capital during childhood in earnings received during adulthood.

The study by Becker and Tomes is theoretical, they have not conducted any estimates of their own, probably due to the difficulty in obtaining data. But they have examined about a dozen empirical studies relating the earnings, income and assets of parents and children. They observe that the point estimates for most of the studies indicate that a 10 percent increase in parents' earnings (or income) increases the children's earnings by less than 2% (Becker and Tomes, 1986:366). They also concluded that: "Almost all earnings advantages and disadvantages of ancestors are wiped out in three generations. Poverty would not seem to be a "culture" that persists for several generations" (Becker and Tomes, 1986:373).

The analysis by Becker and Tomes gives interesting insights, but it does have a shortfall. It does not elaborate on what measure or measures of investment in human capital ought to be taken (like expenditures in health and in education), how they should be combined. Also it does not elaborate on the mechanism by which inheritance of endowments and human capital results in inheritance of a given income level.

In this sense a leap forward was given by Fogel (1992, 1994) who linked "aggregate movements in adult height to long-run changes in standards of living, including income, mortality, and …morbidity" (Strauss and Duncan, 1998:768). The insight Fogel had was the use of height, and variations in height, as measures of previous investments in human capital. Fogel suggested a simple yet precise way of measuring past investments in human capital by its outcome. If the family (and the state) had invested in the child, he/she would have grown, if this investment were not made the child would not have grown.

Based on the case made by Fogel, Strauss and Thomas (1998) observed that:

- √ the income generating capacity of the poorest could be enhanced by some health sector investment (p.767),
- √ there are "correlations between health and labor outcomes",
- √ "health varies over the life course and is the outcome of behavioral choices both during childhood and in later life" (p. 768).
- √ health (measured by height) and productivity are correlated at the individual level (p. 772).
- √ "... in recent years, substantial progress has been made in documenting the existence of a causal impact of health on wages and productivity in low-income settings...."
- √ "health has a larger return at very low levels of health and (perhaps) in jobs requiring more strength. With economic development …one might expect the labor market impact of improved health to decline, especially relative to the impact of education and skill acquisition."

In the case of Brazil, results of several researches conducted by Monteiro and cols.(1993) with data surveyed in the National Study of Household Expenditures, or *Estudo Nacional de Despesa Familiar* (ENDEF), and the National Research on Health and Nutrition, or *Pesquisa Nacional de Saúde e Nutrição* (PNSN), showed that:

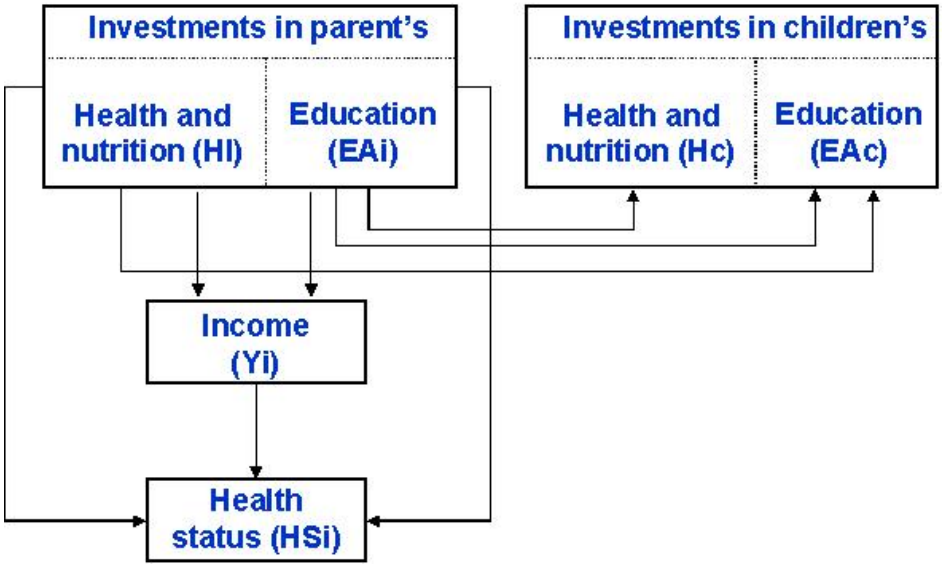
- There was an increase in height of young adults (21-22 years of age), when we compare persons born in 1966-1968 to those born in 1951-53. The increase was of 1.3 cm for males and 1.0 cm for females;
- There was an increase in height of children (7 years of age ± 12 months), comparing children born in 1981-1983 to those born in 1966-68. The increase was of 3.6 cm for males and 3.7 cm for females;
- Height of Brazilian young adults and children was below heights presented in the NCHSI/WHO standard, but the deficit is being reduced. It was reduced in 15% for young adults, both male and female, born between 1951/1953 and 1966/1968; and it was reduced in 50% for children, both male and female, born between 1966-1968 and 1982-1983.

3. METHODOLOGY

Methodological lines to be followed in this study are the ones developed by Fogel (2001) and Barro (1996).

As the first line of analysis, we chose identifying the impact of human capital investment at two privileged points in time: (a) during childhood, involving investments in individuals in terms of health and nutrition; (b) during school age, involving investments on formal education. As outcome of this investment in human capital, we used people's income and their health status. This line of analysis is expressed on the left column of Diagram 1.

DIAGRAM 1: IMPACT OF THE INVESTMENT IN HUMAN CAPITAL ON AN INDIVIDUAL´S INCOME AND HEALTH STATUS, AND THE INTERGENERATIONAL TRANSMISSION OF THIS INVESTMENT



Our survey population, pertaining to this main line, consists of all 20 to 59 year-old adults who had been surveyed by PPV. For indicator of the investment in human capital during childhood, made either by family and/or by state (per lines of Fogel 2001), we used the final height reached by the individual, a measurement which, in societies such as ours, reflects outstandingly well the prevailing health and nutrition status of the individual during the first two years of his/her life. As for investments on formal education, we used the number of school years of the individual as indicator. The outcome indicators regarding health and nutrition investments made during

childhood were: (a) the income (productivity) he/she earned from work; (b) and the overall status of health (self-referred scale).

On a second line of analysis, we pursued the study of the intergenerational transmission of investments in health, nutrition and education. This second line of analysis is expressed on the right column of Diagram 1[8]. We studied household units formed by father and mother in the age group of 19 through 59, and their children between 2 and 7 years old or 15 through 21 years old.

The direct transmission of the investments on nutrition and health from parents to child cannot be investigated in view of the impossibility of controlling the genetic fraction of height transmission. We may, however, study the transmission of these investments on nutrition and health made by the parents, in terms of their investments in the child's education.

As to investments made in the parents' education, we may investigate their transmission in the form of investments made in their children's education, and investments in their children's health and nutrition.

Whatever the case, we must control the family income. The income control enables us to affirm if those investments made in nutrition and health or in education are transmitted independently from the family income, i.e. if individuals of identical income but on whom more investments in education were made (either by parents' or by state) are more likely to invest more in the education (or on nutrition) of their children than those individuals on whom less investments in education have been made.

We also controlled for the child's age due to: (a) possible variations in the child's nutritional status according to age; (b) the association of age and education derived from the expected positive secular trend in education.

The main variables utilized in this study, which are part of the PPV survey, have the definitions expressed below:

- √ Height (measured in centimeters), an indicator of the individual's linear growth and indirectly of health conditions and nutritional status during childhood and adolescence;
- √ Self-reported health status (HS), scaled from 1 to 5 (from 1, excellent health status, till 5, poor health status) intends to investigate the

[8] This line of analysis is presented on Diagram 3.

individual's health history. Based on additional data collected in the PPV questionnaire that registered presence of chronic and/or acute illness, self-reported health status could be validated as a consistent variable to measure an individual's actual health conditions, showing that individuals with poorer self-reported health status tend to report much more often chronic and/or acute diseases than individuals with better self-reported status;

- √ Data on income represent total income from working activities only (measured in units of Brazilian currency: real), excluding financial and other non-productive sources of profits. Given the standard hypothesis about the utility of income, the variable income was constructed as the logarithm of total income (plus one)
- √ Age of the individual was measured in months;
- √ Education is expressed in years of schooling;
- √ Gender, of course, refers to the sex of the individual, male or female (0 for men, one for women)

The study was conducted for two Metropolitan Regions in Brazil, São Paulo and Fortaleza. The choice of these two metropolitan regions was due to the fact that we wanted to compare the impact on the overall status of health of the adult individual and his income, of investments in human capital made during his childhood and also to compare the intergenerational transmission of human capital, between the richest metropolitan region in Brazil and in the Southeast of Brazil – São Paulo – and the poorest metropolitan region in the Northeast of Brazil – Fortaleza..

Table 1 below presents data for the metropolitan regions of the Northeast of Brazil (Fortaleza, Recife and Salvador) and of the Southeast (Belo Horizonte, Rio de Janeiro and São Paulo). The data are presented in *reais* of 1996; in that year the exchange rate was US$1.00 = R$1,0051. One can observe that S. Paulo was the richest metropolitan region in the Southeast (an it is also the richest in the country), with a per capita family expenditure of US$ 5,391.03 and Fortaleza was the poorest metropolitan region in the Northeast (and it is also the poorest in the country), with a per capita family expenditure of US$.2,505.81 We also presented in Table 1 data on the family expenditures per capita on health which give a similar picture.

Table 1

Family Expenditure Per Capita in Selected Metropolitan Regions of Brazil (in reais of September of 1996)

Metropolitan Regions	Population	Family Expenditures Per Capita (Total) R$	Family Expenditures On Health (Per Capita) R$
Fortaleza	**2.509.336**	**2.518,59**	**130,40**
Recife	**2.906.428**	**2.727,75**	**203,10**
Salvador	**2.596.523**	**2.950,10**	**192,60**
Belo Horizonte	**3.551.538**	**4.823,54**	**304,50**
Rio de Janeiro	**10.049.806**	**4.064,76**	**276,80**
São Paulo	**15.867.789**	**5.418,52**	**355,60**

Source: Reis, Carlos O. et alii Avaliação do Gasto Familiar com Assistência Médica no Brasil: O Caso dos Planos de Saúde IPEA, Brasília, s/d Texto para Discussão no. 921, pg. 9 and calculations from the authors.

4. MODELS

The model of the impact of the investment in human capital on the individual's income and health status will investigate the impact of health and nutrition investments and of investments in education made during childhood on the overall status of health of the individual and the income (productivity) he/she earns from work.This was done using the following equations:

$$(1)\ HSi = f(Hi, EAi, Yi)$$

This equation measures the contribution to health status (HSi) of the human capital investment during infancy (Hi) and from infancy to adulthood (EAi) , using the income of the individual as an adult (Yi) as a control variable. It is expected that the coefficients of all variables will be positive.

(2) Yi = f (Hi, EAi, HSi)

This equation shows the following important determinants of an individual's income:

(a) The human capital investment this individual benefited from as a child (Hi);

(b) The human capital investment this individual benefited from infancy to adulthood (EAi);

(c) His/her present health status (HSi).

The coefficients of all these three variables are expected to be positive.

(3) EAi = f (Hi)

The third step is to examine the relation between educational attainment (EA) and height (H) of an individual I, to analyze how good a predictor of educational attainment height is. It is expected that the bigger the investment made in health and nutrition during infancy, the higher the possibility of the individual having a better educational attainment from infancy to adulthood, so the coefficient of the variable Hi is expected to be positive.

The second phase of the study consists in estimating a group of regressions based on models which allow the analysis of the main mechanisms that determine intergenerational transmission of human capital.

(3) Hc = f (EAi)

(4) EAc = f (Hi)

(5) EAc = f (EAi)

Where Hc and EAc are, respectively, the height and the educational attainment of a child c; the variable Hi is the average height of both parents and EAi is the average of the number of years of schooling of both parentst. The per capita income, expressed in logarithm, and age of the child were used as control variables. The group of equations (3), (4) and (5) indicates the impact of the human capital investment:

- √ On the investment made in the development of the child's human capital (Hc) in the two first years and
- √ On the investment made in the formation of human capital of the child (EAc) during adolescence.

Data on children's educational attainment were converted in an educational attainment adequacy index (EAc). The 15 to 21 years old children's educational attainment adequacy index is derived from the comparison between the ideal number of school years calculated for each age group and the individual's actual number of school years at that age. The following scale of school years was considered ideal, since in the case of Brazil a child should start his first year of schooling at age 7.

Table 2

Ideal Number of School Years For Individuals in the 15 to 21 Age Bracket (Brazil)

Age (Ic)	**Ideal number of school years (EA*)**
15 years	8
16 years	9
17 years	10
18 years	11
19 years	12
20 years	13
21 years	14

Thus, the educational adequacy level of the child (EAc) was calculated according to the relation between the ideal educational attainment to his/her age (EA*) and the effectively attended years of school declared (EAr) by the child c of the age group Ic:

$$EAc = \frac{EAr}{EA^*}$$

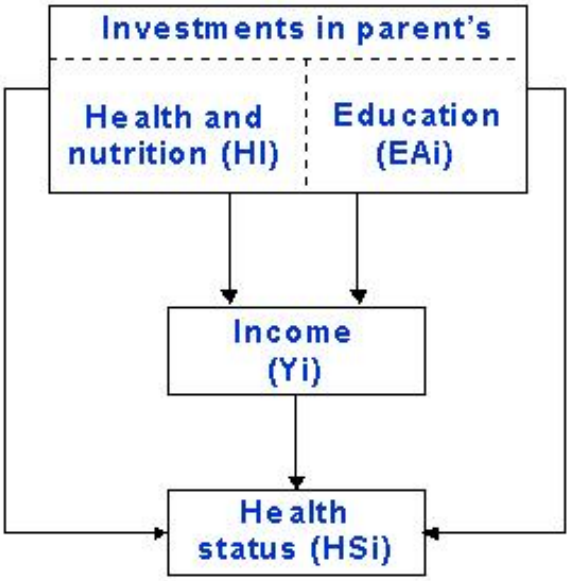
5. RESULTS

Results are presented for each model described in the section on methodology. Regressions which included self-reported health status as dependent variable were run using the method ordered logit in order to fulfill the requirements of self-reported health status as a discrete variable with cardinal classification.

5.1 Impact of the Investment in Human Capital on an Individual's Income and Health Status

Diagram 2 will help us to remember the relationships we are estimating in the first phase of this study. In this phase, we worked with adults in the age bracket 19 to 59 years of age, that is, we excluded from the sample adults with ages lesser than 228 months (19 years old) and adults with ages equal or superior to 720 months (60 years old). Also excluded were registers that did not inform the individual's height.

DIAGRAM 2: IMPACT OF THE INVESTMENT IN HUMAN CAPITAL ON AN INDIVIDUAL´S INCOME AND HEALTH STATUS



1. Relations among an Individual's Health Status, Height, Educational Attainment, and Family Income.

Dependent Variable: Self-reported Health Status (HSi).

Independent Variables: Height (Hi) as proxy for human capital investment made in the individual at childhood, Educational Attainment (EA) as proxy for human

capital investment made in the individual from childhood to adulthood and Income (Yi). [9]

Control Variables: Age (I);Age Squared (I^2); Gender (S); Metropolitan Region (EST).

HSi = f (Hi, EAi, Yi)

Dependent Variable: HS

Method: ML - Ordered Logit (Quadratic hill climbing)

Date: 05/15/05 Time: 17:57

Sample: 1 1737

Included observations: 1708

Excluded observations: 29

Number of ordered indicator values: 5

Convergence achieved after 11 iterations

Covariance matrix computed using second derivatives

	Coefficient	Std. Error	z-Statistic	Prob.
H	-0.000775	0.006608	-0.117306	0.9066
EA	-0.061140	0.010717	-5.704785	0.0000
LY1	-0.056963	0.015928	-3.576336	0.0003
I	-0.004166	0.002386	-1.746213	0.0808
I2	7.44E-06	2.60E-06	2.863215	0.0042
S	0.110775	0.122788	0.902159	0.3670
EST	-0.352266	0.093819	-3.754731	0.0002
Limit Points				
LIMIT_2:C(8)	-2.623156	1.229976	-2.132689	0.0330
LIMIT_3:C(9)	-1.182704	1.228687	-0.962576	0.3358
LIMIT_4:C(10)	0.375841	1.228743	0.305875	0.7597
LIMIT_5:C(11)	2.835302	1.237121	2.291856	0.0219
Akaike info criterion	2.769192	Schwarz criterion		2.804247

[9] As the effects of income increase at decreasing rates, we preferred to use the logarithm of income (Ln); as for some observations the income could be zero, we took the logarithm of income plus one.

Log likelihood	-2353.890	Hannan-Quinn criter.	2.782166
Restr. log likelihood	-2443.824	Avg. log likelihood	-1.378156
LR statistic (7 df)	179.8671	LR index (Pseudo-R2)	0.036800
Probability(LR stat)	0.000000		

The signal of the coefficients of the regression should be interpreted carefully. The health status varies from 1 = excellent to 5 = very poor. Therefore a negative signal means an improvement in health status. Height, educational attainment and income presented a positive an impact on the level of self-reported health status. However, the coefficient of height is not significantly different from zero (with a probability of 90%). This could be due to the fact that income received in the present has a strong relationship with the investment in human capital made during infancy, which we intended to capture through the variable height.

With a high degree of statistical significance, we can state that human capital investment made in an individual from childhood through adulthood, captured by the variable Educational Attainment and the individual's (family per capita) income have a positive impact on the level of self-reported health status. The variable income should be interpreted with caution. It is the present income received by the individual, from different sources. It reflects his ability to work, in the case of wages, but it also could reflect the wealth inherited by this individual, in the case of rents. In every case, the present (family per capita)income is here being used as a measure of the individual’s capacity of acquiring goods and services; among which only the access to health and sanitation services and to educational services are relevant to the present study, with positive impacts on the health status.

There is no significant impact of gender on health status, that is, there is no statistical difference in health status of men and women in the metropolitan regions of Fortaleza and S. Paulo.

Age (I) has the expected behavior. Health status improves with age, at decreasing rates.

The *dummy* for the metropolitan region presents a significant impact on health status. Persons living in São Paulo metropolitan region present a better health status than persons living in the Fortaleza Metropolitan Region.

2. Relations among an Individual's Family income and His Health Status, Height and Educational Attainment

Dependent Variable: Family income (Yi).

Independent Variables: Self-reported Health Status (HS) as current health and nutritional status indicator, Height (H) as proxy for human capital investment made in an individual during childhood, Educational Attainment (EA) as proxy for human capital investment made in an individual from childhood through adulthood.

Control Variables: Age(I); Age Squared (I^2); Gender (S); Metropolitan Region (EST).

Yi = f (Hi, EAi, HSi)

Dependent Variable: LY1

Method: Least Squares

Date: 05/15/05 Time: 18:01

Sample: 1 1737

Included observations: 1708

Excluded observations: 29

LY1=C(1)+C(2)*H+C(3)*EA+C(4)*HS+C(5)*I+C(6)*I2+C(7)*S +C(8)*EST

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-4.066799	1.856829	-2.190185	0.0286
C(2)	0.007701	0.009976	0.772022	0.4402
C(3)	0.177879	0.015901	11.18652	0.0000
C(4)	-0.231706	0.065741	-3.524532	0.0004
C(5)	0.031621	0.003520	8.982678	0.0000
C(6)	-3.25E-05	3.83E-06	-8.475915	0.0000
C(7)	-2.084158	0.178657	-11.66569	0.0000
C(8)	0.181978	0.142635	1.275829	0.2022

R-squared	0.249887	Mean dependent var	3.805340
Adjusted R-squared	0.246798	S.D. dependent var	3.159325
S.E. of regression	2.741889	Akaike info criterion	4.859844
Sum squared resid	12780.53	Schwarz criterion	4.885339
Log likelihood	-4142.307	Durbin-Watson stat	1.975499

Educational Attainment and health status had a positive impact on the dependent variable income. Therefore, investments made in forming human capital from childhood to adulthood and health status as an adult, imply the probability of an individual having a larger income at adulthood, and better access to health, sanitation and education services.

The coefficient of height – our proxy for investment in human capital during infancy – was statistically not different from zero; its effect could have been "captured" by education.

Men earn higher incomes than women. The variables used to capture the effect of age presented the expected behavior, income increasing with age at decreasing rates. The *dummy* variable introduced to capture the effect of the Metropolitan Region at which the individual lived was not statistically different from zero.

Summing up, the result we obtained is that income is a function of the Educational Attainment of the individual – which reflects the investment in human capital made in this individual from childhood to adulthood – of the individual's health status and his gender, irrespective of the Metropolitan Region he lives, whether the richest one (S Paulo) or the poorest one (Fortaleza).. Elder individuals earn a larger income in working activities than younger ones, but with age earnings increase at a decreasing rate.

3. Relations among an Individual's Educational Attainment (EA) and his/her Height (H).

$$EAi = f(Hi)$$

Dependent Variable: Educational Attainment (EA) as proxy for human capital investment made in the individual from childhood to adulthood

Independent Variable: Height (Hi) as proxy for human capital investment made in the individual at childhood.

Control Variables: Age (I);Age Squared (I^2); Gender (S); Metropolitan Region (EST).

Dependent Variable: EA

Method: Least Squares

Date: 05/15/05 Time: 17:59

Sample: 1 1737

Included observations: 1737

EA=C(1)+C(2)*H+C(3)*I+C(4)*I2+C(5)*S+C(6)*EST

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-24.24292	2.758979	-8.786916	0.0000
C(2)	0.176032	0.014646	12.01876	0.0000
C(3)	0.013354	0.005376	2.483914	0.0131
C(4)	-1.96E-05	5.84E-06	-3.358625	0.0008
C(5)	1.768196	0.268927	6.575009	0.0000
C(6)	-0.017627	0.217258	-0.081134	0.9353

R-squared	0.115029	Mean dependent var	7.195740
Adjusted R-squared	0.112473	S.D. dependent var	4.496251
S.E. of regression	4.235857	Akaike info criterion	5.728497
Sum squared resid	31058.45	Schwarz criterion	5.747357
Log likelihood	-4969.200	Durbin-Watson stat	1.183257

This regression intend to verify the relationship between investment in human capital made during infancy, captured by the variable H, with investment in human capital made in an individual from childhood through adulthood, captured by the variable Educational Attainment (EA).

The coefficient for height is positive and significantly different from zero, indicating that investment in human capital made during infancy is an important determinant of investment in human capital made from childhood through adulthood.

This characteristic does not differ among Metropolitan Regions, it is as important in São Paulo as it is in Fortaleza (the coefficient for Metropolitan Regions is not statistically significant different from zero). It does differ by gender, that is, given the level of investment during infancy, men tend to have more years of schooling.

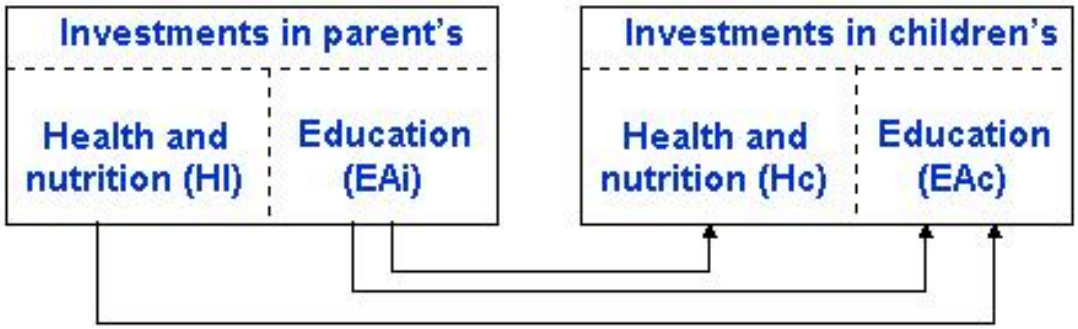
Age presents the expected behavior, Educational Attainment tends to increase with age, at decreasing rates.

5.2 Intergenerational Transmission of Human Capital

Diagram 3 has been taken from Diagram 1 and will remind us of the relationships we are estimating on this second phase of our study.

DIAGRAM 3

IMPACT OF THE INVESTMENT IN HUMAN CAPITAL ON THE INTERGENERATIONAL TRANSMISSION OF THIS INVESTMENT.



The regressions for which children´s height is the dependent variable, refer to children in the age bracket 2 years (24 months) to 7 years (84 months) old. The regressions for which Educational Attainment Adequacy of the child is the dependent variable, refer to children in the age bracket 15 years (l80 months) to 21 years (252 months) old. In both cases, the data on Educational Attainment of parents and height of parents refer to the averages calculated for fathers and mothers.

1. Relationship between the Child's Height (Hc) and Parents' Educational Attainment (EAi)

A child's height is a proxy of investments on health and nutrition made in children of the age bracket 2 to 7 and the parents' Educational Attainment is a proxy of the investment in human capital made in parents at a younger age.

Dependent Variable: Child's Height (Hc).

Independent Variable: Parents' Educational Attainment (EAi).

Control Variables: Family's Per Capita Income (YPC); Child's Age (Ic), Metropolitan Region (EST)

Hc = f (EAi)

FAMILIES WITH YOUNGEST CHILD IN THE 2-7 AGE BRACKET

Dependent Variable: H

Method: Least Squares

Date: 05/15/05 Time: 18:16

Sample: 1 362

Included observations: 320

Excluded observations: 42

H=C(1)+C(2)*EAI+C(3)*I+C(4)*I2+C(5)*EST

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	62.30837	3.917188	15.90640	0.0000
C(2)	0.341694	0.095148	3.591175	0.0004
C(3)	0.882978	0.153515	5.751751	0.0000
C(4)	-0.002804	0.001412	-1.986662	0.0478
C(5)	0.995440	0.812803	1.224699	0.2216

R-squared	0.687484	Mean dependent var	103.5688
Adjusted R-squared	0.683516	S.D. dependent var	12.28422
S.E. of regression	6.910725	Akaike info criterion	6.719528
Sum squared resid	15043.81	Schwarz criterion	6.778408
Log likelihood	-1070.124	Durbin-Watson stat	2.018088

Results show a positive impact from parent´s Educational Attainment - a proxy of the investment in human capital made in parents at a younger age - .on the child's height - a proxy of investments on health and nutrition made in children of the age bracket 2 to 7 One should bear in mind that the parents' Educational Attainment has a two-fold role. It acts directly on the intergenerational transmission of human capital and acts also indirectly, since better educated parents tend to have a higher family income and as a consequence are more efficient in the transmission of human capital to their children in the first two years of their lives.

Age presents the expected result, with height increasing with age, at decreasing rates. The *dummy* for Metropolitan Region is not significantly different from zero, therefore the investment in human capital made in parents when they were young has a

positive impact on investments on health and nutrition of their children, regardless of the fact that parents reside in São Paulo or Fortaleza.

2.Transmission to Children of Investments in Parent´s Health and Nutrition

On this topic, we will study the relationship of the educational attainment of children (EAC) between 15 and 21 and their parents' height (Hi), as a proxy of human capital investment made in the parents in the first two years of their lives.

Dependent Variable: Child's Educational Attainment (EAc).

Independent Variable: Parents' Height (Hi).

Control Variables: Gender (S); Metropolitan Region (EST)

EAc = f (Hi)

FAMILIES WITH CHILDREN BETWEEN 15 AND 21

Dependent Variable: EAC

Method: Least Squares

Date: 05/15/05 Time: 18:11

Sample: 1 368

Included observations: 347

Excluded observations: 21

EAC=C(1)*HI+C(2)*S+C(6)*EST

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.003722	0.000137	27.08813	0.0000
C(2)	0.101500	0.025259	4.018323	0.0001
C(6)	0.074865	0.025642	2.919681	0.0037
R-squared	0.113115	Mean dependent var		0.683415
Adjusted R-squared	0.107958	S.D. dependent var		0.248882
S.E. of regression	0.235064	Akaike info criterion		-0.049313
Sum squared resid	19.00769	Schwarz criterion		-0.016033
Log likelihood	11.55579	Durbin-Watson stat		0.187347

In this regression and in the next one, were educational adequacy (EAc) is the dependent variable, age was not introduced as an independent variable, since it was used for the construction of the educational attainment index (see section on *Models*, Table 2)

Results indicate that the parents' height, a proxy of human capital investment made in the parents in the first two years of their lives, has a positive, and very significant, impact on a child's educational attainment adequacy. The coefficient for gender is significant and positive, indicating that given parent's height and the Metropolitan Region of residence, women have a better educational adequacy. Also the coefficient for the *dummy* on Metropolitan Region is significant and positive, indicating that given parent's height and gender of the child, the educational adequacy of children living in São Paulo is better than the adequacy of children living in Fortaleza.

3. Relationship between the Educational Attainment (EAc) of individuals in the age bracket 15 to 21 and Parents' Educational Attainment (EAi)

Educational attainment of individuals in the age bracket 15 to 21 can be considered a measure of the outcome of investments in human capital made in parents when they were younger.

Dependent Variable: Child's Educational Attainment (EAc).

Independent Variable: Parents' Educational Attainment (EAi).

Control Variables: Gender (S), Metropolitan Region (EST).

EAc = f (EAi)

FAMILIES WITH CHILDREN BETWEEN 15 AND 21

Dependent Variable: EAC

Method: Least Squares

Date: 05/15/05 Time: 18:13

Sample: 1 368

Included observations: 347

Excluded observations: 21

EAC=C(1)*EAI+C(2)*S+C(3)*EST

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.057582	0.002680	21.48292	0.0000
C(2)	0.268212	0.026312	10.19349	0.0000

C(3)	0.269050	0.025759	10.44473	0.0000
R-squared	0.186638	Mean dependent var		0.683415
Adjusted R-squared	0.193537	S.D. dependent var		0.248882
S.E. of regression	0.271901	Akaike info criterion		0.241851
Sum squared resid	25.43198	Schwarz criterion		0.275130
Log likelihood	-38.96109	Durbin-Watson stat		1.919391

Parents' education – a measure of the investment in human capital made in parent's when they were younger - bears a significantly positive influence on the child's educational attainment adequacy. The coefficient for gender is significant and positive, meaning that given the educational attainment of parent's and the Metropolitan Region where they lived, girls had a high educational attainment adequacy. The coefficient of the *dummy* for Metropolitan Region was also positive and significant, therefore given the educational attainment of parent's and gender of the children, persons (children) living in São Paulo had a higher educational attainment adequacy

6. CONCLUSION.

Our work is based on two lines of thought. In the first line of thought we worked with data relative to the individual. We tried to verify the impact upon the individual's present health status of investments in the formation of his/her human capital and of his/her (family) income. We also tried to verify the impact upon the individual's (family) income of investments in the formation of his/her human capital and of his/her present health status. The main results obtained were:

- ✓ With a high degree of statistical significance, we can state that human capital investment made in an individual from childhood through adulthood and family income have a positive impact on the level of self-reported health status. The impact of income can be attributed to the fact that persons with higher income can have better sanitation, and buy better medical services. There was no significant statistical difference in the health status of men and women.

  Persons living in the Metropolitan Region of São Paulo had a better health status than persons living in the Metropolitan Region of Fortaleza. This also can be attributed to the fact that S Paulo has better sanitation and medical services.

- ✓ Educational attainment and health status had a positive impact on income. Therefore, investments made in forming human capital, through childhood to adulthood, and the health status as an adult, imply the probability of an individual having a larger income at adulthood, and better access to health, sanitation and education services. Men earn higher incomes than women. There is no statistical significant difference of income received by people residing in São Paulo Metropolitan Region and Fortaleza Metropolitan Region.

  This is interesting, because in the paper "Health, Human Capital And Economic Growth In Brazil". presented at the 44th Congress of

European Regional Science Association, Porto, Portugal, 2004 [10] we observed that individuals living in the richest region of Brazil (the Southeast) earn more than those living in the Northeast region. That is, when we define Region broadly, comprising a metropolitan region, several cities with different population sizes and rural areas, we observe differences in the income level of the Regions; when we define Region narrowly, comprising just a metropolitan region, we observe no significant differences on the income level of the Regions In other words, Metropolitan Regions are more homogenous in respect to income than broadly defined regions.

√ It was also verified that **Educational Attainment is a function of investment in human capital during infancy**. Women had a better Educational Attainment than men. The Metropolitan Region where the individual resides makes no difference in terms of his/her Educational Attainment. This could be attributed to urbanization economies. By this we mean that in Metropolitan Regions like Fortaleza and São Paulo there is a concentration of educational facilities and adults living in these metropolis could have had equality of opportunities to access educational facilities when they were young.

The second line of thought was relative to the intergenerational transmission of human capital. The main results were:

- ✓ **Relationship Between the Child's Height and Parents' Educational Attainment -** The impact from parent's Educational Attainment on the child's height is positive, that is, the investment in the formation of human capital of parent's, from childhood to adulthood, had a positive

[10] Campino A.C.C., Monteiro C.A., Conde W.L., Machado,F.M.S. "Health, Human Capital And Economic Growth In Brazil". São Paulo (Br), Paper Presented At The 44th Congress Of European Regional Science Association , Porto, Portugal, 2004

impact on the investment they are doing in the formation of human capital of their children during their infancy.

One should bear in mind that the parents' Educational Attainment has a two-fold role. It acts directly on the intergenerational transmission of human capital and acts also indirectly, since better educated parents tend to have a higher income and as a consequence are more efficient in the transmission of human capital to their children in the first two years of their lives.

The fact that the *dummy* variable for Metropolitan Region is not significant could be due to the existence of no significant differences in nutritional status among Metropolitan Regions.

- ✓ **Transmission to Children (in the age bracket 15 to 21) of Investments in Parent´s Health and Nutrition - The** investment in human capital made in parents when they were infants is transmitted to the next generation in terms of better Educational Attainment Adequacy. For women this Adequacy is better than for men.

  The Metropolitan Region where the child resides makes a difference; children living in the São Paulo Metropolitan Region have a better education adequacy**.** This could be due to the fact that there is a difference in the quality of education between the two Metropolitan Regions being considered. São Paulo being a larger metropolitan area presents agglomeration economies in education, which implies better educational facilities at lower costs, best qualified teachers, lesser rates of drop-out and repetition.

  - √ **Relationship Between the Educational Attainment of individuals in the age bracket 15 to 21 and Parents' Educational Attainment -** Parents' Educational Attainment bears a significantly positive influence on the child's Educational Attainment Adequacy. This intergenerational transmission of investments in human capital through education is stronger in the Metropolitan Region of São Paulo than in the Metropolitan Region of Fortaleza.

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